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Comment on nhess-2021-170

Anonymous Referee #1

Referee comment on "Submarine landslide source modeling using the 3D slope stability analysis method for the 2018 Palu, Sulawesi, tsunami" by Chatuphorn Somphong et al., Nat. Hazards Earth Syst. Sci. Discuss., https://doi.org/10.5194/nhess-2021-170-RC1, 2021

Review of: *Submarine Landslide Source Modeling using the 3D Slope Stability Analysis Method for the 2018 Palu-Sulawesi Tsunami*; by Somphong et al., Submitted to NHESS, https://doi.org/10.5194/nhess-2021-170

Somphong et al. applied, for the first time to the best of their knowledge, a numerical model based on Hovland's 3D slope stability analysis for cohesion-frictional soils, to provide a better understanding of the potential submarine landslide-induced tsunami phenomenon. They study the 2018 Palu-Sulawesi tsunami event and compared their results with various post-event field observational data such as runup heights and flow depths around the bay and Palu city, waveforms recorded by the Pantoloan tide gauge, and video-inferred waveforms from various locations around the Bay.

This is a very interesting investigation, important contribution to the study of earthquake induced tsunamigenic submarine landslides, and in my opinion is suitable for publication in NHESS after considering the following comments.

Main comments

Tsunami generation by strike slip earthquakes

The USGS moment tensor of the Palu-Sulawesi earthquake is not a pure strike-slip (https://earthquake.usgs.gov/earthquakes/eventpage/us1000h3p4/moment-tensor) and thus, such a mechanism is capable of generating some tsunami waves, mainly due to the effect of the rake component. Recent studies (e.g. Elbanna et al., 2021; Frucht et al., 2019) have shown the complexity and importance of tsunamis generated by strike-slip earthquakes. Therefore, in my opinion, the potential contribution of the coseismic deformation induced by the Palu-Sulawesi earthquake to tsunami generation should not be ignored, or at least examined if relevant.

Indeed, the authors mention the need for adding coseismic sources for the modeling and the important conclusion raised by Sepúlveda et al. (2020) (lines 355-357 in the present manuscript). However, they attribute the misfit between their modeling and field observations to variations on the time of landslide initiation, etc., rather than first modeling the combined effect of tsunami generation by both coseismic deformation and subaerial and submarine landslides, and then discuss the reasons of misfit. This line of investigation is not mentioned in the Conclusions section as well.

The issue of seismogenic submarine landslides that generate tsunamis should be discussed in the introduction not only by regrading Palu-Sulawesi investigations but also by relating to worldwide published literature. For example, the relations between earthquakes magnitude, including of strike slip events, and the distance between the seismogenic fault and the tsunamigenic submarine landslides, were studies by Salamon and Di-Manna (2019); the superposition of tsunami waves generated by coseismic deformation and submarine landslide was already demonstrated in several studies (e.g. Baptista et al., 2019; Perez del Postigo Prieto et al., 2021), etc.

Soil data

I found it difficult to follow the various soil layers and strata described in the text (Section 2.1.2) and Table 2 (what is the meaning of 'Underground'? Which of the base layer used for the modeling, the dry or saturated conditions?), and sketched in Figures 3 (two layers only) and Figure 5 (3 layers).

There is much discussion on the potential, limitations and uncertainties of the Hovland's approach to identify the location of the submarine slope failures. Was this approach use to identify on-land and coastal slope failures that are well recognized and mapped along the Palu Bay, and thus validate the Hovland's approach for identifying potential submarine landslides?

General impression

The tone I felt while reading the Discussions and Conclusions sections is negative and thus discounts the achievements of this project. The critic approach displayed in these sections is highly appreciated, however it gives the impression that the project failed to achieve its goals – which in my opinion is not the case at all. I would suggest the authors to first emphasize their achievements in line with the stated goals (lines 100-108), than discus the shortcomings, and finally propose what should be done and improved next.

Figures

I suggest adding a general location map with an inset map that sows the study area. There is a need to add the location of the 2018 epicenter, the pattern of the seismogenic fault and surface rupture, in relation with the study area. Also, there is a need to show the various mechanisms proposed for this earthquake, because of the reasons mentioned above.

Figure 1: the text markered blue is hard to read.

Figure 2: The modeling procedures start with "Setting… "; Why not continue the other stages by "Calculating…" and "Validating…"?

Text fonts is some Figures (e.g. 7 and 8) are too small to read. Please improve.

Specific and technical comments (by line numbering)

11, 83, etc,: "visible landslides" – do you mean subaerial landslide, such that initiated on land, entered the sea and generated a tsunami? Or submarine landslides that produced visible cloudiness in the water? Please define the exact terminology in the abstract and explain it later on in the text where relevant.

16-17: "surveyed soil properties" – If I understood correctly, properties of on-land, dry soil, were extrapolated onto submarine seabed conditions with some corrections? In my intuitive understanding, the word 'soil' refers to on-land areas and 'seabed' to the upper (soil) layer in marine environment. Please define and explain your terminology, describe the process of transforming on-land dry soil properties to seabed fully saturated conditions, in short in the abstract, and later on along the text in section 2.1.2, and where else relevant:

Is the extrapolated seabed lithology of Palu Bay the same as the dry soil material around the Bay; Is the specific weight also the same? Is the soil unit weight (e.g. line 176) is 11.7 -12.4 Kg per 1 cubic meter, or should be Kilonewtons or Tons per cubic meter?

17: After describing the landslide volume, location and mechanical properties used for the modeling, one expects to see the properties used to simulate the collapse process, i.e. speed of motion, distance to rest, etc. This should also be addressed and explained in the text, especially in the methodology and Figure 2.

18-19: "The results were combined with the other tsunami sources, i.e., earthquakes and observed coastal collapses,…" – I am not sure I understood correctly what exactly you mean:

Did you mean in 'results' - tsunamis induced by submarine landslide that were modeled in this study, and in 'other tsunami sources' - tsunamis simulated by other researchers due to coseismic deformation generated by the Palu-Sulawesi earthquake, as well as tsunamis induced by the observed subaerial coastal collapse?

In other words, do you mean that tsunami components generated by coseismic deformation and subaerial landslides were investigated in this study?

Please clarify in the abstract and explain in details in the text.

30: What was the tsunami type of the ninth event?

41: An unanticipated …

46-47, 50-51: Are these the reasons why tsunami component due to coseismic deformation were not simulated in this work?

53: Please consider mentioning the relevant references, since this is the first time you mention the Pantoloan tide gauge record and other studies of landslide sources.

70: …acceptable…

73-74: …Carvajal et al. (2019)…

76: … Sepúlveda et al. (2020)… Please check for missing parentheses elsewhere in the text (e.g. line 288, 356…)

91: what does it mean …upper outside…., and …lower part…?

94: you mean previous studies of the Palu-Sulawesi event?

103-104: not clear, please rephrase

108: you mean: …with parameters calculated by tsunami simulation that are based on the developed landslide model… ?

153: should be "… safety factor > 1" ?

193: what is "inviscid"

196: Topographic and bathymetric data

217-218: Are Upper-, Middle- and Lower- Bay refer to Northern, Central and Southern parts of the Bay?

218: You mean: vulnerable to submarine slope failure?

252: …in the range of ???? m error?

267: What does it mean : “Moreover, the simulation in this study can slightly overestimate.”?

279-280: Figure 10 reads first apparent signal as positive wave of few cm within the first 1-2 minutes, then the first negative wave at minus ~2 m… within 5 minutes, and then the maximal positive… ?

319: saturated

329: … in Palu city, all generally….

346: suitable

362: … landslide geometry, shows…

References not mentioned in the manuscript

Elbanna et al., 2018. Anatomy of strike-slip fault tsunami genesis. Proceedings of the National Academy of Sciences, 118 (19), e2025632118; DOI: 10.1073/pnas.2025632118

Baptista, M.A., Miranda, J.M.A., Omira, R., 2019. The 28 February 1969 earthquake and tsunami in the North East Atlantic - A Review. AGU Fall Meeting Abstract #NH43E-0985. American Geophysical Union.

Frucht et al., 2019. A Fresh View of the Tsunami Generated by the Dead Sea Transform, 1995 Mw 7.2 Nuweiba Earthquake, along the Gulf of Elat-Aqaba. *Seismological Research*

Letters, 90 (4): 1483-1493. https://pubs.geoscienceworld.org/ssa/srl/article/90/4/1483/571541/a-fresh-view-of-the-tsunami-generated-by-the-dead; https://doi.org/10.1785/0220190004.

Perez del Postigo Prieto et al., 2019. Parametric Study of Tsunamis Generated by Earthquakes and Landslides. Journal of Marine Science and Engineering 7, no. 5: 154. https://doi.org/10.3390/jmse7050154.

Salamon, A. and Di Manna, P., 2019. Empirical constraints on magnitude-distance relationships for seismically induced submarine tsunamigenic landslides. Earth-Science Reviews, 191: 66–92. https://doi.org/10.1016/j.earscirev.2019.02.001.